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**First Expert Group Meeting on Computerized
Maintenance System in Metallurgy ***

**Prague, Czechoslovakia
28 January - 1 February 1985**

REPORT **

* Organized by the United Nations Industrial Development Organization (UNIDO) in co-operation with the Institute for Automation and Industrial Management (INORGA-Prague) under the auspices of the Czechoslovakian Ministry of Metallurgy and Heavy Engineering.

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INTRODUCTION

The First Expert Group Meeting (EGM) on Computerized Maintenance Management Systems (CMMS) in Metallurgy was organized by UNIDO in co-operation with INORGA Prague Institute, Czechoslovakia, from 28 January to 1 February 1985 with the following main objectives:

- a) to examine the current situation and trends in development of CMMS in the Iron and Steel Industry in developing countries;
- b) to identify the most effective way to develop and implement CMMS in the Iron and Steel Industry in developing countries;
- c) to develop the practical recommendations and guidelines for implementation of CMMS in developing countries;
- d) to discuss and determine the experiences in the development of human resources to support the application of CMMS;
- e) to propose follow-up activities for completed pilot projects and effective forms of dissemination of know-how in the field.

The expert representatives of 13 countries (for complete list see Annex 1) attended the deliberations of the EGM. The EGM proceedings consisted of introductory presentation by UNIDO representative and five individual reports (optionally supported by other contributions) followed by plenary and individual discussions, consultations, plant industrial visits and excursions to technical laboratories; full EGM programme is given in Annex 2.

As the chairman of the EGM was elected Mr. B.S. Ramachandra (India). The discussions were monitored and final conclusions and recommendations were prepared by an elected working group consisting of UNIDO representative. B.R. Ramachandra (India), P. De Groote (Belgium), A. Kagramanov (USSR) and J.V. Krouzek (Czechoslovakia), the latter being also appointed as the EGM rapporteur.

The EGM papers were published by UNIDO under separate volumes and have been distributed to all participants. Their copies are available with the Metallurgical Section at the UNIDO Vienna Headquarters. Final conclusions and recommendations of the EGM are included in Chapter 2 of this Report. Chapter 3 then presents the short synopsis of the main reports for the purpose of an overall overview. To deal with specially highlighted problem areas during the EGM in more detail, Chapter 4 of the Report provides guidelines and recommendations of CMMS development and implementation in developing countries. The development of human resources is dealt with in Chapter 5 and the follow-up activities of completed CMMS pilot projects are outlined in Chapter 6.

CONCLUSIONS AND RECOMMENDATIONS

The EGM considers the problem of maintenance of plant and machinery and other capital assets of primary importance in all countries, in particular with utmost importance in developing countries - actual plant availability is usually considerably lower than that really required by the industry (in some cases actual plant utilization being 15-35% of the planned capacities), employing 30-40% of the company manpower, and contributing highly (25%) to the total manufacturing costs. In order to improve the status of maintenance, the EGM recommends an intensive action both on plants and as on a national and regional level to improve maintenance. The intensive action will comprise of the following:

1. A scheme of promotion of maintenance awareness in the industries should be formulated by UNDP/UNIDO and presented by the SIDFA to the respective Governments. This particular aspect should be part of a large industrial programme during the year of maintenance in developing countries as recommended in the Conference on Human Resources, Yaoundi, 1983.
2. Based on this promotion action, industries must be directed to introduce a sound and scientific maintenance organization comprising organizational structure, data collection methodology, planned maintenance and repair programmes, spare parts and maintenance materials procurement, manufacturing and usage control. The manning of the organizational structure should be corresponding with highly qualified and trained personnel.
3. A permanent expert working group should be constituted by UNIDO consisting of representatives of developing and developed countries and experts/consultants with large experience. This working group should periodically meet in order to analyse and discuss the status of maintenance in general and in particular the introduction and development of computer managed maintenance systems (CMMS) in the developing countries. They will formulate necessary and practical

corrective/improvement measures to bring up the maintenance status in concerned countries to a reasonable higher level.

4. The pattern of organizational structure having equal hierarchical level between maintenance and production is felt suitable. It is also felt by the expert group that the centralized maintenance system structure would give better results in achieving ultimately the implementation of CMMS in the industry vis-a-vis the mixed or decentralized structure.
5. Maintenance planning and management procedures should first be executed manually and automation should be gradually introduced. If main frame computer applications are already in operation, then a centralized CMMS can be more effectively introduced. If not, application of a distributed system following modularly step-by-step automation is recommended, starting with stores inventory accounting and control followed by the other logical steps, details of which are available in the Report.
6. The expert group considered that a lot of maintenance problems find their origin at the point of selection of equipment and supplies, during the project stage, where it was observed that the maintenance specialists are not associated. This is a matter of serious concern which has brought a crisis situation in the maintenance status in many developing countries. The expert group recommends the following action to prevent such situation in the future:
 - a) associate systematically as a basic requirement, the maintenance specialists right from the project conception, contract negotiations, selection of supplier and equipment, follow-up from erection and commissioning;
 - b) elaborate detailed specifications to be incorporated in the contract, concerning maintainability and reliability of equipment, plant standards, extensive technical documentation, manufacturing drawings of spare parts and components, designation, transport

handling, preservation and storage of spare parts, training of maintenance personnel, guaranteed supply of critical spare parts for a stipulated period along with a rational price escalation clause, extensions of technical assistance by the supplier as and where needs are according to well-defined requirements.

A purchase strategy on the Government level in developing countries should be formulated involving maintenance function which will cover the points brought out above.

7. Linking of condition based/predicative maintenance systems with appropriate instruments in usage on selected critical equipment complexes to this computer system can be done after stabilization of CMMS for a reasonable period. This is a sophistication in maintenance technique and technology which will result in better availability and reliability. The same holds for the use of advanced mathematical modelling and Operational Research methods within the CMMS.
8. The concepts of CMMS, numerous functions and programme modules as well as guidelines for their implementations as introduced in iron and steel industries are applicable to other industries, in particular, the basic industries sector. The know-how and experience gained with CMMS in the iron and steel should therefore be effectively transferred to these basic industries.
9. The existing expertise in UNDP/UNIDO completed and/or on-going projects should be effectively shared through extensive promotion and publication of relevant information, establishment of national and regional technical consultancy and training centres par excellence for more formalized dissemination of know-how and the preparation and execution of similar CMMS oriented projects on both national and regional level to provide for more effective utilization of results and further development in the field.

SYNOPSIS OF THE REPORTS PRESENTED BY THE EXPERTS

Introductory Presentation: Status of world iron and steel industry
and UNIDO technical assistance in CMMS

by G.D. Surguchov, UNIDO

The introductory presentation consists of three parts. In the first part the status of world iron and steel industry and the prevailing trends in the steel production, materials and steel products flows (and their interdependency) are reviewed to provide the necessary background for the specialized topics of the EGM - the development and implementation of CMMS.

In the second part the role of UNIDO, its objectives, structure, technical assistance and projects' implementation are dealt with, in particular the activities of the Division of Industrial Operations and Metallurgical Industries Section are described, the organization of expert group meetings being one example of the transfer of know-how and exchange of experiences' activities.

The third part is concerned with the specialized topic of the EGM - CMMS. The justification and results of the completed, on-going and pipeline CMMS projects are being discussed, using as illustrative examples the developments of these types of projects in Czechoslovakia and Egypt, respectively. It is shown that the process of transfer of know-how from completed projects leads to the establishment of national and/ or regional training and consultancy centers, these providing technical assistance to other basic industrial sectors. The feasibility of these concepts and other fundamental problems in the field of CMMS development to be answered by the EGM panel are dealt with in the concluding part of the paper.

Report 1: Maintenance functions and organization structure of modern managed maintenance systems

by J.V. Krouzek

In the introduction a brief overview of Czechoslovak UNDP/UNIDO project on computerized maintenance in iron and steel industry is outlined. The successful implementation of the project is being shown using high benefits' figures of 63 million CS Crowns (approximately 5.3 mil. US \$) stemming from project savings due to lower inventories, increased productivity and availability of both production and maintenance resources.

Maintenance functions and activities together with maintenance organizational structure and factors, influencing maintenance department organization are described; based on these general maintenance functions the major subsystems of modern CMMS are outlined and described, including the CMMS integrating elements and software support functions.

Evaluation of multiple aspects of CMMS development and implementation is then given with the recommendations regarding system step-by-step development and implementation, system modularity and integrity, modern interactive design and documentation techniques, hardware and software support and the development of human resources.

In the final part of the Report the dissemination of know-how activities upon the completion of the pilot CMMS project are dealt with, in particular the Czechoslovak follow-up UNDP/UNIDO projects introducing the centralized consultancy and training programme and giving the ground to the establishment of a National Technical Consultancy and Training Centre (NTCTC) for computer systems in maintenance and production in basic industries. The Report is concluded by the summary of experiences in the transfer of know-how process on international level under the UNDP/UNIDO auspices and TCDC schemes.

Report 2: Maintenance services in developing countries

by P. De Groote

In the first, introductory part, the major industrial maintenance problems in developing countries are featured, showing how critical the situation in this area is. The overview of the general principles of maintenance field services in the iron and steel industry follows, depicting also the organization of maintenance department in a steelplant, in particular the central maintenance support office, the mechanical and electrical divisions, the instrumentation division, central maintenance workshops and spare parts management and stores.

In the next part of the Report the problems in the design, supply, erection and commissioning of equipment for the new plant are treated, emphasizing the importance of sound planning, purchasing, constructing and installation for the future operation and maintenance of the new plant. Technical documentation objectives, contents and delivery, together with various systems of coding of equipment and spare parts are then described. Problems of rehabilitation of the production facilities and replacement of parts, assemblies and subassemblies are briefly summarized.

The final part of the Report is devoted to the operation of preventive maintenance including lubrication, testing and inspection procedures with illustrative examples. Throughout the Report, case studies of specific examples of the above problems in various developing countries are given.

Report 3: Computer based preventive maintenance system development and implementation experience in Egypt

by D. Tantawy

In the first part of the Report the critical role of maintenance to the industrialization of developing countries is stated and the

corresponding growth of maintenance planning and organization with specific maintenance problems in Egyptian Iron and Steel Company is shown, the UNDP/UNIDO projects for CMMS being the answer to these pressing problems.

One of the major parts of CMMS implemented in EISCO under UNDP/UNIDO project was the preventive maintenance and planned repairs system which enables to reduce most effectively down-time and maintenance costs, prolonged the life time of equipment and helped in the standardization on the plant level (thus also reducing the production costs).

The planning of maintenance, workshop scheduling and inventory control systems are described in full detail showing necessary procedures, input data, output listings, documentation used, coding systems, implementation steps and numerous practical methods and hints for both manual and computer based systems.

The sequence of UNDP/UNIDO technical assistance projects is also briefly discussed, showing the implementation phases and their progress from single project on CMMS to other projects in production planning, material tracking and process control as well as the preparation of plans for African regional centre par excellence in metallurgical and engineering industries (to provide for the transfer of know-how process).

Report 4: Development and implementation of computerized managed maintenance systems - VOEST ALPINE experience

by E. Reichel and W. Pilz

In the introductory part of the Report the VOEST ALPINE group, its metallurgical plants, organization of maintenance activities and their automation are thoroughly described.

The main body of the Report is devoted to the case study examples - the computerized system for planning and control of central maintenance workshop in VOEST ALPINE Donawitz and other works and the planned

maintenance systems installed in ZISCO, Zimbabwe and BAYOU, USA. For the Donawitz works the standard software PS package was implemented with the following modules: order handling, bill of material processing, preparation of job plans, preparation of shop floor documents, machine centers work assignment, shopfloor control and production reporting, cost control. The individual modules are briefly described as well as the project schedule, benefits and the hardware support. In a similar way the maintenance systems in Linz and Liezen VOEST ALPINE works and ZISCO and BAYOU companies are described. The interesting feature of these systems being the effective use of microcomputer hardware support. The maintenance system package comprises of the servicing, inspection and reporting modules with optional central workshop order preparation, spare parts ordering and personnel capacity planning.

The role of microcomputers is specially highlighted in the Report dealing with microcomputer condition monitoring, maintenance performance measuring and microcomputer networks; the last part of the Report is then devoted to the VOEST ALPINE industrial services technical assistance programme, especially in the maintenance area.

Report 5: Some special issues of designing computer-aided management information system for steel works maintenance services

by A. Kagramanov

The Report describes experiences with the application of computers to maintenance management and operations in USSR, in particular, the most critical area considered - the supply of standard spare parts, assemblies and subassemblies for main production facilities.

The equipment components are classified depending on their possibilities to be replaced, reconditioned and standardized. Behavioral peculiarities of equipment standard components are then treated in full detail covering inventory management, production equipment state reporting and analysis and recording of equipment component movement routes. For these problem areas the corresponding CMMS functions/ subsystems are described, i.e. Spare parts inventory accounting and allocation subsystem, Equipment shutdown and failure accounting subsystem and Equipment units movement reporting subsystem.

In the conclusions of the Report it is shown that the Spare parts reporting and allocating subsystem can provide an integrating super-structure upon other CMMS subsystems, the availability of statistical data for equipment shutdown and failure, components movements and spare parts standardization being the most important prerequisites for the overall CMMS implementation.

DEVELOPMENT AND IMPLEMENTATION OF CMMS IN IRON AND STEEL INDUSTRIES
IN DEVELOPING COUNTRIES: GUIDELINES AND RECOMMENDATIONS

The EGM considers that there is a need for CMMS in the iron and steel industries in developing countries. Before introduction of CMMS in developing countries one should take into account the following pre-conditions:

- Good functioning organizational structure; i.e.
 - organizational chart
 - data collection and evaluation methodology
 - planned maintenance and repair programmes
 - well-trained personnel;
- Complete and adequate technical documentation concerning the equipment;
- Codification methodology for equipment and spare parts;
- Master spare parts accounting system.

Computerization can then be done after a certain reasonable period of successful working of the manual system, through a logical step-by-step approach:

- Step 1: Spares and maintenance material inventory accounting and control.
- Step 2: Work order for job execution including breakdown request and reporting.
- Step 3: Equipment and maintenance monitoring.
- Step 4: Job plans, preventive maintenance and repair schedule.

- Step 5: Performance analysis and evaluation of status of equipment condition vis-a-vis planned.
- Step 6: Update preventive maintenance and repair schedules in reference to the analysis of equipment condition.
- Step 7: Estimate of manpower required, jobwise and catalog of jobs.

To introduce a CMMS in an existing plant one should make a differentiation between two situations:

- Plant is already equipped with mainframe central computer.
The unused capacity could be used for step-by-step extension to CMMS application.
- Plant has no mainframe computer application wherein one may adopt a centralized or distributed system approach following modularly step-by-step automation and integration.

The introduction of CMMS could first be done in a pilot production area of a large-scale pilot plant and then be extended to other production areas of the plant. This experience would also allow to develop CMMS for medium small-scale plant. Iron and steel industries in developing countries would be the best suited nucleus for this pilot plant and extension to other industries.

General functional structure of CMMS based on the basic maintenance functions and organizational structure of maintenance may include the following functions:

1) Inventory and Stores Management:

- spare parts catalog
- inventory record keeping
- inventory control
- parts and materials allocation
- disbursement

- 2) Purchasing of Spares, Materials and Services:
 - purchase requisition
 - purchase order generation
 - vendor data update
 - follow-up
- 3) Maintenance Work Order Creation:
 - job requests
 - verification and work order generation
 - dispatching
- 4) Maintenance Planning:
 - plant catalog
 - preventive maintenance planning
 - repair planning
 - equipment lay-offs planning
 - material requirements planning
 - manpower requirements planning
 - maintenance cost planning
- 5) Spare Parts Manufacture and Reconditioning:
 - drawings
 - bills of material
 - routing operation
 - work centres
 - capacity planning and operation scheduling
 - shop floor monitoring and control
- 6) Maintenance Work Order Scheduling:
 - job selection
 - CPA method application
 - capacity planning and job scheduling
 - releasing maintenance jobs
 - dispatching
 - rescheduling

7) Maintenance Work Order Monitoring:

- equipment lay-offs monitoring
- maintenance order monitoring
- job status reporting
- manpower loading and efficiency
- maintenance cost monitoring

8) History and Analysis:

- job completion reporting
- maintenance cost analysis
- equipment analysis
- preventive maintenance and planned repair cycles and standards development

9) System Software Support Function:

- data bank and coding system for the above described application functions
- teleprocessing network system and on-line interactive enquiry support depending on the centralized/distributed processing approach
- application transactions support
- computer operating system and associated housekeeping programmes.

The CMMS design, development and implementation will be essentially speeded up through the introduction of software for interactive system design, computerized documentation and interactive programme testing and development.

The problem of suitable computer hardware to support CMMS functions application, choice of centralized/distributed system concept and other specific aspects, e.g. licencing, leasing policies, engineering services, minimum configuration technical parameters should be one of the tasks to be developed by the Maintenance Working Group in UNIDO as recommended by this EGM.

DEVELOPMENT OF HUMAN RESOURCES

Development of human resources to support the application of modern managed maintenance systems should be based on an essentially practical approach in the following fields:

- Technical documentation
- Preventive maintenance and lubrication programmes
- Job preparation
- Maintenance data collection and evaluation methodology
- Inspection
- Stores inventory accounting
- Instructions for end users of CMMS
- Software development of CMMS with system analysts and designers and application and systems programmers

Human resources should be developed using the various forms of expert working group and consultancy meetings on regular basis, specialized seminars, study tours and demonstrations, fellowships, expert and consultancy services.

The importance of extension of existing projects in the field of maintenance should be stressed in order to transfer the acquired experience and capacities to other industries of the country or region concerned. This could be in the form of periodically repeated training programmes and should be one of the tasks to be developed by the Maintenance Working Group in UNIDO as recommended above.

FOLLOW-UP OF COMPLETED PILOT PROJECTS AND DISSEMINATION OF KNOW-HOW

There is a need for better integration and co-ordination in the matter of know-how expertise and resources accumulated at UNDP/UNIDO with implementation and completion of CMMS projects in developing countries. The achievements and successful results of the completed CMMS projects in the Arab Republic of Egypt (DP/EGY/81/012) and Czechoslovakia (DP/CZE/77/005) need extensive promotion through publication of relevant information to bring home the awareness of advantages to developing countries. This process should be in conformity with conclusions of the Third UNIDO Consultation at Caracas in 1982, particularly concerning transfer of know-how/expertises.

The existing project in Czechoslovakia for the establishment of a National Technical Consultancy and Training Centre and a similar project under preparation in the Arab Republic of Egypt on the regional level should provide the ground for preparation, development and implementation of CMMS projects in other developing countries, using the forums mentioned in Chapter 5. These projects should be considered as a regional nucleus for TCDC and extended to the centres of excellence. To achieve the objective, existing expertise in UNIDO projects in other countries should also be utilized.

ANNEX I

LIST OF PARTICIPANTS

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ANNEX 2

EXPERT GROUP MEETING-PROGRAMME AND SCHEDULE SUMMARY

Prague, 28 January - 1 February 1985

Hotel accommodation: IH Internacional, Praha 6, nam. Druzby 1

Meeting place: IH Internacional, conference premises on 10th floor

Secretarial/information services: EGM secretarial, room No. 225

January 28

Monday

08.30-09.00

EGM opening

09.00-10.00

Introductory presentation:

EGM objectives and UNIDO technical assistance
to developing countries

(Senior Industrial Development Officer, UNIDO)

10.00-12.00

Report 1:

Maintenance functions and organizational structure
of modern managed maintenance systems, overview
of major subsystems and integrating elements and
evaluation of the multiple aspects of implementation
of computerized maintenance systems, including
hardware, software and resources and follow-up
activities in the dissemination of know-how
(using case study - practical example of Czechoslovak
UNDP/UNIDO pilot project implementation)

(Mr. Krouzek - INORGA Prague, Czechoslovakia)

13.30-14.30

Co-paper A:

Experience of implementation and use of computerized
maintenance system in East Slovakian Steelworks, Kosice
(Mr. Bilicka - East Slovakian Steelworks, Kosice,
Czechoslovakia)

14.30-17.30

Report 2:

Maintenance field services, various types of systems used for the planning, installation and documentation and coding of equipments and spare parts, rehabilitation of facilities, replacement of parts/assemblies and preventive maintenance operation, incl. lubrication, testing and inspection using case studies of specific examples in various developing countries
(Mr. De Groote - Belgium)

January 29

Tuesday

08.30-10.30

Report 3:

Computer based preventive maintenance system - development and implementation experience in ARE, incl. the evaluation of benefits in both performance/ productivity and financial areas (using a case study example of UNDP/UNIDO project implementation in EISCo, ARE)
(Mr. Tantawi - ARE)

11.00-12.00

Co-paper B:

Data base for maintenance management systems on personal computer
(Mr. Toth - INORGA Kosice, Czechoslovakia)

13.30-16.30

Report 4:

Development and implementation of maintenance planning and scheduling and monitoring systems for maintenance and repair shop and field activities (using a case study of VOEST ALPINE experience for various plants in both industrially developed

and developing countries)

(Mr. Reichel - Austria)

17.30-18.30

Evening discussion and personal computers
demonstration

January 30

Wednesday

08.30-10.30

Report 5:

Spare parts and assemblies repair and reconditioning
and manufacture, purchasing, stocking and inventory
control systems, incl. costing and budgeting and
the application of mathematical modelling (using
examples from metallurgical plants with centrally
planned economics)

(Mr. Kagramanov - USSR)

11.00-12.00

Co-paper C:

Use of microprocessors for equipment maintenance
diagnostics

(Mr. Smolik - INORGA Prague, Czechoslovakia)

13.30-16.00

Visit of INORGA experimental laboratory

16.00-18.30

Election of the working group for the preparation
of final report and recommendations

January 31

Thursday

05.30-06.00

Transfer to Prague airport

Visit of East Slovakian Steelworks, Kosice - plants,
pilot implementation, terminal clusters and the
computer centre and follow-up discussions

19.00-21.30 Meeting of the working group

February 1

Friday

08.30-12.00 a) Final meeting of the working group

13.30-15.00 Final plenary discussions

15.00-17.30 Presentation and approval of recommendations